



NASA STTR 2006 Phase I Solicitation

T4 Goddard Space Flight Center

The mission of the Goddard Space Flight Center is to expand knowledge of the Earth and its environment, the solar system, and the universe through observations from space. To assure that our nation maintains leadership in this endeavor, we are committed to excellence in scientific investigation, in the development and operation of space systems, and in the advancement of essential technologies.

Subtopics

T4.01 Earth Science Sensors and Instruments

Lead Center: GSFC

Center: GSFC

As part of its mission, NASA seeks to develop a scientific understanding of the Earth system and its responses to natural and human-induced changes to enable improved prediction of climate, weather, and natural hazards for present and future generations. By using breakthrough technologies for terrestrial, airborne, and spaceborne instrumentation, we seek to observe, analyze, and model the Earth system to discover how it is changing and the consequences for life on Earth.

This subtopic is to help provide advanced remote sensing technologies to enable future Earth Science measurements.

Active Remote Sensing Instruments (Lidar)

Lidar remote sensing systems are required to meet the demanding measurement requirements for future Earth Science missions. Instruments are solicited that enable or support the following Earth Science measurements:

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- High spatial and temporal resolution observations of the land surface and vegetation cover (biomass);
 - Profiling of clouds and aerosols;
 - Wind measurements (direct-detection technology only);
 - Tropospheric and stratospheric ozone and CO₂ (profiling and total column);
 - Measurement of the air/sea interface and mixed layer.

Systems and approaches will be considered that demonstrate a capability that is scalable to space or can be mounted on a relevant platform (UAV or aircraft). New systems and approaches are sought that will:

- Enable one of the Earth Science measurements listed above;
- Enhance an existing measurement capability by significantly improving the performance (spatial/temporal resolution, accuracy, range of regard); and/or
- Substantially reduce the resources (cost, mass, volume, or power) required to attain the same measurement capability.

Passive Remote Sensing Instruments for Unmanned Aerial Vehicles (UAVs)

Spectral imaging devices for remote sensing onboard UAVs are also desired. In particular, uncooled infrared and thermal spectral imager instruments with the following specifications are solicited:

- Instrument must be less than 2 lbs and no larger than 0.05 m³ in volume;
- Must operate autonomously in coordination with the onboard flight plan;
- Must have a built-in data acquisition system;
- Spectral bands must all be coregistered and the data must be GPS time tagged;
- Spectral bands should be centered at 3.75, 3.96, and 11 microns as well as a band in the visible at 0.6 microns; and
- Quantization bit resolution should be 10-bit minimum.

Active Remote Sensing Instruments (Radar) for Aircraft and Unmanned Aerial Vehicles (UAVs)

Active microwave remote sensing instruments are required for future Earth Science missions with initial system concept development and science measurements on aircraft and UAVs. New systems, approaches, and technologies are sought that will enable or significantly advance the capability for:

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- Tropospheric wind measurements within precipitation and clouds (X- through W-band);
 - Large Ground Penetrating Radars (GPR) (P-band and lower);
 - Rain measurements using differential or dual-frequency approaches (X- through Ka-band).

Data Compression

New approaches to data compression, also known as source coding, are needed to assist in transporting science instrument data within constrained communication channels, and/or to reduce the requirements for onboard data storage. Additional benefits of data compression include more science data return and facilitating the direct broadcast of science data to ground stations. To target multiple missions, implementations should conform to the Consultative Committee for Space Data Systems (CCSDS, www.ccsds.org) recommendation CCDDS 121.0-B 1. This solicitation seeks development of new data compression processors that:

- Can process science instrument data at over 50 Msamples/sec and take science data input from 1-bit/sample and preferably up to 32 bits/sample;
- Can demonstrate radiation tolerance required for both near-Earth and deep space missions; and
- Consume less than 2 watts of electrical power at 50 Msamples/sec.

T4.02 Space Science Sensors and Instruments

Lead Center: GSFC

Center: GSFC

Sensors and Instruments for space science applications are:

Analytical Instrumentation

Technical innovations are sought for sensitive, high-precision, analog electronics for measurements of low voltages, currents, and temperatures. Work on cryogenic transition edge detection techniques for X-ray astronomy in particular, and IR sensors with high quantum efficiency. New robust, efficient integration techniques that are scalable to commercial manufacturing efforts are sought.

- High-resolution IR sensors with high quantum efficiency, especially novel ion-implanted silicon devices, and arrays with sensitivities better than 10⁻¹⁶ W per root Hz;
- Cryogenic devices, such as SQUID amplifiers and SQUID multiplexers, superconducting transition-edge temperature sensors, and miniature, self-contained low-temperature He refrigerators;
- Analog application-specific integrated circuits (ASICs) with large dynamic range (> 10⁵) and low power (< 100 microwatts per channel); and
- Novel packaging techniques and interconnection techniques for analog and digital electronics.

Optics

Larger telescopes in space (compared to the 6 m James Webb Space Telescope) demand lighter weight materials and new concepts. For example: designs including inflatable structures for lenses, mirrors, or antennas. Order of magnitude increases are envisioned. Applications of new materials could bring a new dimension to astronomy.

Goals for Future NASA Optical Systems

	X-ray Mirrors	UV Mirrors	Visible Scanning	Lidar Telescope	NIR* Earth Science Systems	Far Infrared to submillimeter Wavelength
Energy Range	0.05 - 15 keV	100 - 400 nm	400 - 700 nm	355 - 2050 nm	0.7 - 4 mm	20 - 800 mm
Size	1 - 4 m	1 - 2 m	6 - 10+ m	0.7 - 1.5 m	3m - 4 m	10 - 25 m
Areal Density	< 0.5 kg/m ² /grazing incidence	< 10 kg/m ²	< 5 kg/m ²	< 10 kg/m ²	< 5 kg/m ²	< 5 kg/m ²
Surface Figure	1/150 at λ = 633 nm	Diffraction Limited at λ = 300 nm	1/150 at λ = 500 nm	1/10 at λ = 633 nm	1/75 at λ = 1 mm	1/14 at λ = 20 mm

* Near-infrared

- Large-area, lightweight (< 15 kg/m²) focusing optics, including inflatable or deployable structures;
- Novel laser devices (e.g., for lidars) that are tunable, compact, lower power and appropriate for mapping planetary (and lunar) surfaces. Future lidar systems may require up to ~1.5 m optics and novel designs; and
- Fresnel-zone X-ray focusing optics to form large X-ray telescopes with small apertures but high angular resolution-better than 1 milli-arc-second. Besides newly developed optics, these missions will require formation flying of spacecraft to an unprecedented level.

Mars and Lunar Initiative Technologies

The new Exploration Initiative (Code T) will embark upon an ambitious plan of robotic and human exploration of Mars with intermediate work to be done on the Moon. A broad program of analysis and resource identification is being planned, including X-ray and Gamma-ray spectroscopy. Exploiting the existing resources will be an important part of these initiatives rather than moving resources from place to place. These resource investigations will be conducted from orbit and from landers, both of which have differing requirements. On missions to Mars and other planets, instruments are typically limited to ~5 - 10 kg maximum.

- Low-weight, high throughput X-ray diffraction systems at 60 keV so that sample spectra can be accumulated in minutes or hours, not days;
- Laser-based X-ray generators (up to 60 keV), both compact and lightweight;
- Improved scintillator resolution for Gamma-rays up to 10 MeV; and
- High spatial resolution X-ray detectors, for producing ~50 meters or less maps from orbiting spacecraft, also with high throughput.

Computing

Massively parallel computer clusters for more complicated problems (in General Relativity, electrodynamics and

"space weather," for example) are becoming more important. Ways to increase performance and reliability and lower cost are called for.

- Novel computing techniques for simulations (including hydrodynamics, stellar evolution, general relativity calculations, etc.);
- New high-performance, low-cost, reliable massively-parallel computers (i.e., Beowulf clusters); and
- Validation tools and software for space weather simulations and modeling.

UAV and Balloon-Craft Technologies

Both remotely piloted (unmanned airborne vehicles) and balloon instrumentation technologies are sought. New techniques and materials for forming "super-pressure" balloons and ways of formation flying or station-keeping with balloons would enable new science from this inexpensive platform, especially in the unmanned exploration of other planets.

- Super-pressure balloon manufacturing technologies;
- Station-keeping and trajectory control devices for balloons;
- New architectures and technologies for remote sensing applications; and
- Trajectory simulation tools and software.